

5 cathode, and a primary electricity using device
6 within the external circuit, comprising the steps of
7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode
9 to generate, for a first period of time, an
10 electric current within the external circuit for
11 operating the primary electricity using device,
12 the cell operating conditions being selected such
13 that, during the course of said first period of
14 time, the cathode potential is maintained above
15 0.66 volt and cell performance decreases;
16 B. regenerating the cell after Step A by a)
17 providing a hydrogen containing fuel to the anode
18 while operating said cell using procedures
19 selected to reduce the cathode potential to below
20 0.50 volt, said procedures including the steps of
21 i) stopping the flow of oxidant to the cell, ii)
22 disconnecting the primary electricity using
23 device and replacing it with a battery in the
24 external circuit, and iii) providing a flow of
25 hydrogen containing gas to the cathode, and
26 b) maintaining the cathode potential below the
27 said 0.50 volt for a second period of time
28 sufficient to essentially restore the cell
29 performance decrease which occurred during the
30 course of Step A; and,
31 C. sequentially repeating Steps A and B to reduce
32 the decrease in cell performance over time.

Delete Claims 3-7 of the original patent and add new claims 10-19 as follows:

1 10. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating
11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time, the
14 cathode potential is maintained above 0.66 volt and
15 cell performance decreases;

16 B. regenerating the cell after Step A by
17 a) providing a hydrogen containing fuel to the anode
18 while operating said cell using procedures selected
19 to reduce the cathode potential to below 0.50 volt,
20 said procedures including the steps of i)
21 disconnecting the primary electricity using device
22 from the external circuit and connecting an
23 auxiliary resistive load in its place, and
24 ii) stopping the flow of oxidant to the cell and
25 allowing the oxidant remaining within the cell to be
26 consumed at the cathode creating a current flow
27 through the auxiliary resistive load within the
28 external circuit; and, b) maintaining the cathode
29 potential below the said 0.50 volt for a second
30 period of time sufficient to essentially restore the
31 cell performance decrease which occurred during the
32 course of Step A; and,

33 C. sequentially repeating Steps A and B to reduce the
34 decrease in cell performance over time.

1 11. The method according to claim 10, wherein in Step B
2 said cell operating procedures are selected to reduce

3 cathode potential to 0.1 volt or less for said second
4 period of time.

1 12. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating
11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time, the
14 cathode potential is maintained above 0.66 volt and
15 cell performance decreases;

16 B. regenerating the cell after Step A while the
17 primary electricity using device within the
18 external circuit remains connected across the anode
19 and cathode and while continuing to provide a
20 hydrogen containing fuel to the anode and an oxygen
21 containing oxidant to the cathode using procedures
22 selected to reduce the cathode potential to below
23 0.50 volt for a second period of time sufficient to
24 essentially restore the cell performance decrease
25 which occurred during the course of Step A, said
26 procedures including increasing the oxidant
27 utilization to at least 70% for said second period
28 of time; and,

29 C. sequentially repeating Steps A and B to reduce the
30 decrease in cell performance over time.

1 13. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode

3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

- 7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating
11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time, the
14 cathode potential is maintained above 0.66 volt and
15 cell performance decreases;
- 16 B. regenerating the cell after Step A while the
17 primary electricity using device within the
18 external circuit remains connected across the anode
19 and cathode and while continuing to provide a
20 hydrogen containing fuel to the anode and an oxygen
21 containing oxidant to the cathode using procedures
22 selected to reduce the cathode potential to below
23 0.50 volt for a second period of time sufficient to
24 essentially restore the cell performance decrease
25 which occurred during the course of Step A, said
26 procedures including increasing the current for
27 said second period of time; and,
- 28 C. sequentially repeating Steps A and B to reduce the
29 decrease in cell performance over time.

- 1 14. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating
11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time, the
14 cathode potential is maintained above 0.66 volt and
15 cell performance decreases;

16 B. regenerating the cell after Step A by
17 a) providing a hydrogen containing fuel to the
18 anode while operating said cell using procedures
19 selected to reduce the cathode potential to below
20 0.50 volt, said procedures including the steps of
21 i) stopping the flow of oxidant to the cell and
22 replacing it with a flow of inert gas, and
23 ii) disconnecting the primary electricity using
24 device from the circuit and connecting an auxiliary
25 resistive load in its place; and,
26 b) maintaining the cathode potential below the
27 said 0.50 volt for a second period of time
28 sufficient to essentially restore the cell
29 performance decrease which occurred during the
30 course of Step A; and,
31 C. sequentially repeating Steps A and B to reduce
32 the decrease in cell performance over time.

1 15. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of
7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to

9 generate, for a first period of time, an electric
10 current within the external circuit for operating
11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time,
14 the cathode potential is maintained above 0.66
15 volt and cell performance decreases;

16 B. regenerating the cell after Step A by

17 a) providing a hydrogen containing fuel to the
18 anode while operating said cell using procedures
19 selected to reduce the cathode potential to below
20 0.50 volt, said procedures including the steps of
21 i) stopping the flow of oxidant to the cathode and
22 replacing it with a flow of hydrogen, ii)
23 disconnecting the primary electricity using device
24 from the circuit and leaving the circuit open
25 until the cathode potential falls to below 0.50
26 volt; and, b) maintaining the cathode potential
27 below the said 0.50 volt for a second period of
28 time sufficient to essentially restore the cell
29 performance decrease which occurred during the
30 course of Step A; and,

31 C. sequentially repeating Steps A and B to reduce the
32 decrease in cell performance over time.

1 16. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating

11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time, the
14 cathode potential is maintained above 0.66 volt and
15 cell performance decreases;

16 B. regenerating the cell after Step A by

17 a) providing a hydrogen containing fuel to the
18 anode while operating said cell using procedures
19 selected to reduce the cathode potential to below
20 0.50 volt, said procedures including the steps of
21 i) stopping the flow of oxidant to the cell, and
22 ii) disconnecting the primary electricity using
23 device and replacing it with a power supply in the
24 external circuit, and
25 b) maintaining the cathode potential below the said
26 0.50 volt for a second period of time sufficient to
27 essentially restore the cell performance decrease
28 which occurred during the course of Step A; and,

29 C. sequentially repeating Steps A and B to reduce the
30 decrease in cell performance over time.

1 17. The method according to claim 16, including, in
2 Step B, in addition to steps i) and ii), step iii)
3 providing a flow of hydrogen containing gas to the
4 cathode.

1 18. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating

11 the primary electricity using device, the cell
12 operating conditions being selected such that,
13 during the course of said first period of time, the
14 cathode potential is maintained above 0.66 volt and
15 cell performance decreases;

- 16 B. regenerating the cell after Step A by a)
17 providing a hydrogen containing fuel to the anode
18 while operating said cell using procedures selected
19 to reduce the cathode potential to below 0.50 volt,
20 said procedures including the steps of i) stopping
21 the flow of oxidant to the cell and replacing it
22 with a flow of gas selected from the group
23 consisting of carbon dioxide, methane, natural gas,
24 propane, and butane, and ii) disconnecting the
25 primary electricity using device from the circuit
26 and leaving the circuit open until the cathode
27 potential falls to below 0.5 volt; and, b)
28 maintaining the cathode potential below the said
29 0.50 volt for a second period of time sufficient to
30 essentially restore the cell performance decrease
31 which occurred during the course of Step A; and,
32 C. sequentially repeating Steps A and B to reduce
33 the decrease in cell performance over time.

1 19. A method of operating a fuel cell having a PEM as the
2 electrolyte, an anode on one side of the PEM, a cathode
3 on the other side of the PEM, an external electric
4 circuit connecting the anode and cathode, and a primary
5 electricity using device within the external circuit,
6 comprising the steps of

- 7 A. providing a hydrogen containing fuel to the anode
8 and an oxygen containing oxidant to the cathode to
9 generate, for a first period of time, an electric
10 current within the external circuit for operating
11 the primary electricity using device, the cell